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Environmental Protection
Agency
Washington DC 20460

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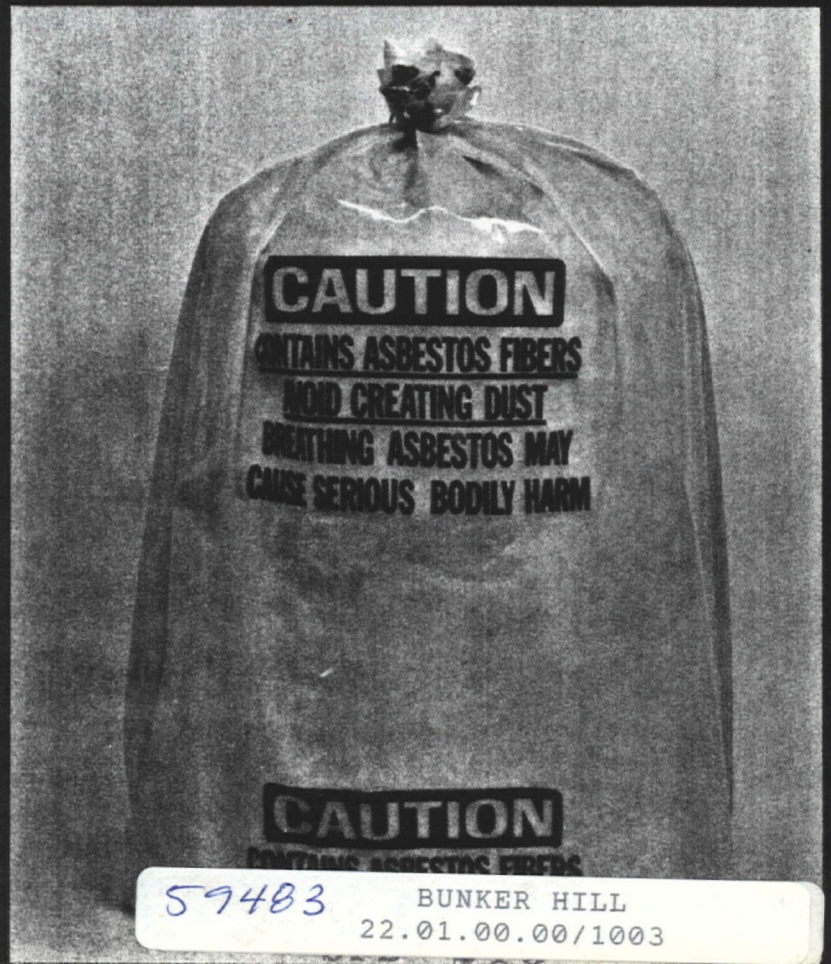
Office of Solid Waste

EPA

Asbestos Waste Management Guidance

- Generation
- Transport
- Disposal



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1 Introduction

The Environmental Protection Agency (EPA) and the Occupational Safety and Health Administration (OSHA) have been concerned with the potential health hazards associated with exposure to asbestos since the early 1970s. The concern is based on medical evidence relating to exposure of airborne asbestos by asbestos workers and their families to various types of cancer as well as noncancerous respiratory diseases.

In recognition of these health hazards, this manual provides guidance on how best to handle asbestos-containing waste materials during generation, transport, and final disposal. Waste handling practices presented include not only those needed to meet current EPA and OSHA requirements, but also additional recommendations reflecting practices needed to further minimize exposure to asbestos. In most cases, the recommendations are consistent with state-of-the-art procedures currently being followed by most knowledgeable asbestos waste handling firms. However, because state and local requirements may be more restrictive than federal standards, these agencies should be contacted before handling asbestos containing materials.

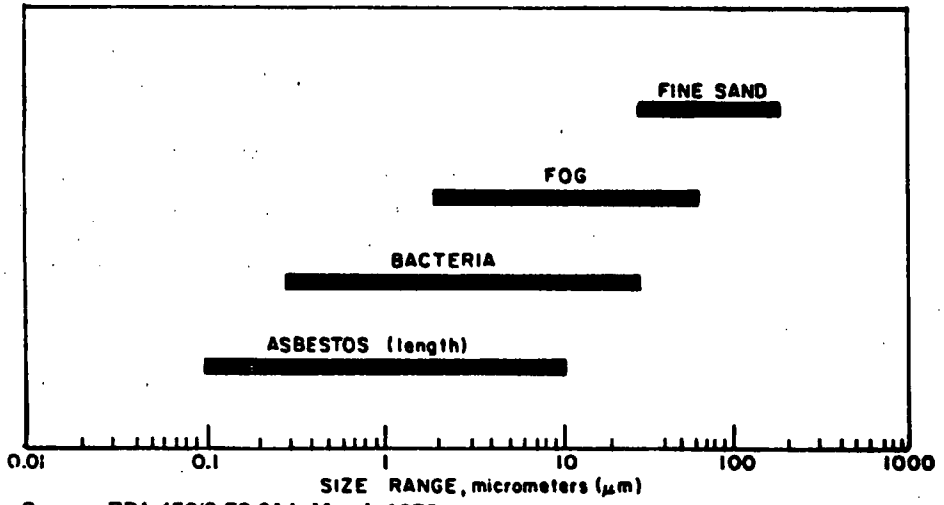
Description of Asbestos

Asbestos is a naturally occurring family of fibrous mineral substance. The typical size of asbestos fibers, as illustrated relative to other substances in Figure 1, is 0.1 to 10μ in length, a size that is not generally visible to the human eye. Somewhat longer fibers are used in making textile products. When disturbed, asbestos fibers may become suspended in the air for many hours, thus increasing the extent of asbestos exposure for individuals within the area.

EPA regulations identify the following types of asbestos: chrysotile, amosite, crocidolite, anthophyllite, actinolite, and tremolite. Approximately 95 percent of all asbestos used in commercial products is chrysotile. Asbestos became a popular commercial product because it is noncombustible, resistant to corrosion, has a high tensile strength, and a low electrical conductivity. However, asbestos had very little use until the early 1900's when it was employed as thermal insulation for steam engines. Since then, asbestos fibers have been mixed with various types of binding materials to create an estimated 3,000 different commercial products. Asbestos has been used in brake linings, floor tile, sealants, plastics, cement pipe, cement sheet, paper products, textile products, and insulation. The amount of asbestos contained in these products varies significantly, from 1 to 100 percent, depending on the particular use.

The potential of an asbestos-containing product to release fibers is dependent upon its degree of friability. Friable means that the material can be crumbled with hand pressure and, therefore, is likely to emit fibers. The fibrous or fluffy spray-applied asbestos materials found in many buildings for fireproofing, insulating, sound proofing, or decorative purposes are generally considered friable. Pipe and boiler wrap are also friable and found in numerous buildings. Some materials, such as vinyl-asbestos floor tile, are considered nonfriable and generally do not emit airborne fibers unless subjected to sanding or sawing operations. Other materials, such as asbestos cement sheet and pipe, can emit asbestos fibers if the materials are subjected to breakage or crushing in the demolition of structures that contain such materials. For this reason, such materials are considered friable under the National Emission Standards for Hazardous Air Pollutants (NESHAP) regulations for the demolition of structures.

Figure 1. Asbestos size comparison with other particles.



Source: EPA 450/2-78-014, March 1978.

Identifying Asbestos

Only on rare occasions can the asbestos content in a product be determined from product labeling or by consulting the manufacturer, since most products as placed in use are no longer labeled. A description of common asbestos-containing products is presented in Section 2 of this manual. Further information on asbestos content of consumer products is available through the Consumer Product Safety Commission Hotline:

Continental United States	1-800-638-2772
Maryland only	1-800-492-8363
Alaska, Hawaii, Puerto Rico, Virgin Islands	1-800-638-8333

Positive identification of asbestos requires laboratory analysis of samples. Standard laboratory analysis using polarized light microscopy (PLM) may cost $30 to $60 per sample. For information on locating a laboratory capable of performing the analysis, contact any of EPA's Regional Asbestos Coordinators listed in Appendix B or call EPA's toll-free number for assistance:

Continental United States	1-800-334-8571 ext. 6741

For additional technical information and to obtain EPA's publication regarding sampling and analysis of asbestos entitled "Guidance for Controlling Friable Asbestos-Containing Materials in Buildings" (EPA 560/5-83-002), contact any of EPA's Regional Asbesto Coordinators listed in Appendix B or call EPA's toll-free TSCA hotline:

Continental United States	1-800-424-9065
Washington, DC only	554-1404

Health Concerns Related to Inhalation

Medical studies of asbestos-related diseases have revealed that the primary exposure route is inhalation. Also, the studies suggest that there does not appear to be a safe level of exposure (e.g., a threshold) below which there would be no chance of disease. The exposure may be classified as "occupational exposure" of workers involved, for example, in mining, milling, manufacturing, fabricating, construction, spraying, or demolition activities; "paraoccupational exposure" of workers' families due to asbestos on work clothes taken home; or "neighborhood exposure" of people living or working near such operations. The following diseases can result from inhalation of airborne asbestos fibers:

Asbestosis—A noncancerous respiratory disease that consists of scarring of lung tissues. Symptoms of asbestosis include shortness of breath and rales, a dry crackling sound in the lungs during inhalation. Advanced asbestosis may produce cardiac failure and death. Asbestosis is rarely caused by neighborhood exposure.

Lung Cancer—Inhaled asbestos particles can produce lung cancer independent of the onset of asbestosis. In most lung cancer patients, a cough or a change in cough habit is found. A persistent chest pain unrelated to coughing is the second most common symptom.

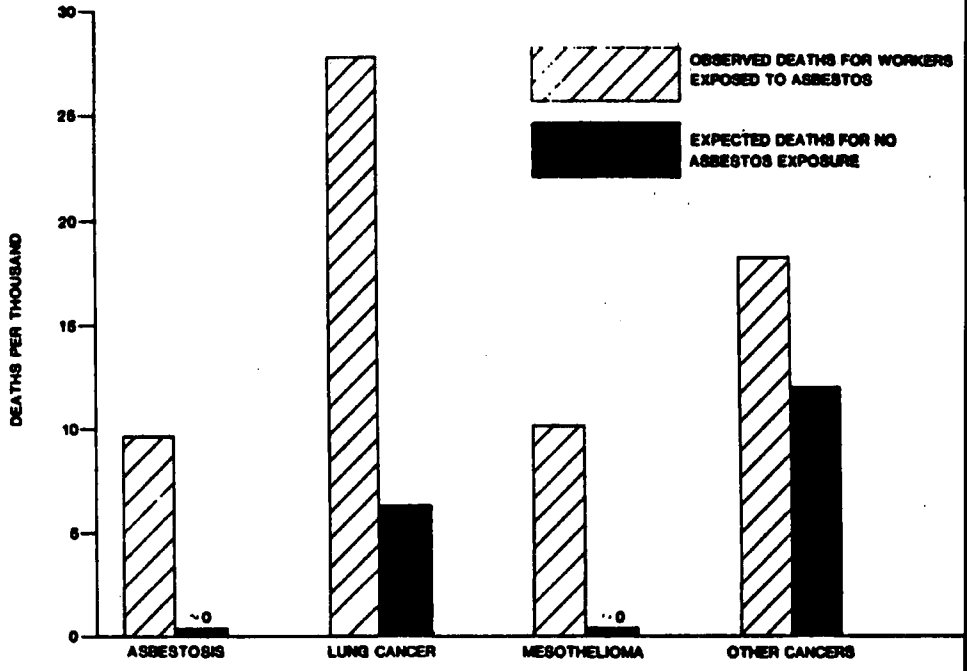
Mesothelioma—This is a rare cancer of the thin membrane lining of the chest and abdomen. Most incidences of mesothelioma have been traced directly to a history of asbestos exposure. The earlier in life that one begins inhaling asbestos, the higher the likelihood of developing mesothelioma in later life. Thus, there is concern over exposure of school children to asbestos. The common symptoms are shortness of breath, pain in the walls of the chest, or abdominal pain. Mesothelioma is always fatal.

Other Cancers—Some medical studies have suggested that exposure to asbestos is responsible for some cancers of internal organs including the esophagus, larynx, oral cavity, stomach, colon, and kidney. It is theorized that inhaled asbestos fibers are absorbed into the blood stream and carried to these other parts of the body.

Symptoms of asbestos respiratory disease generally do not appear for 20 or more years after the initial exposure to airborne asbestos. However, early disease detection is possible by a medical examination including a medical history, breathing capacity tests, and a chest x-ray.

Most health risk data pertain to groups of asbestos workers with relatively high exposures. A study of mortality for 17,500 asbestos insulation workers is summarized in Figure 2. The study compares death rates among insulation workers exposed to asbestos and other workers not exposed to asbestos. Based on this and other studies, the National Institute for Occupational Safety and Health (NIOSH) has reported that persons exposed to asbestos may have 5 times the chance of developing an asbestos- related disease, compared to similar nonexposed persons.

Figure 2. Expected and observed mortality among asbestos insulation workers



Source: ASTM 834, PCN 04- 834000-17, July 1984.

Studies have shown that exposure to asbestos and cigarette smoking combine to create a significantly higher risk of developing an asbestos-related disease. Statistics compiled by NIOSH indicate that a smoker exposed to asbestos may have 50 times the chance of developing lung cancer compared to a nonexposed nonsmoker. Some information suggests that quitting smoking can reduce this high risk.

Health Concerns from Ingestion and Contact with Skin

There have been no conclusive studies to date indicating that ingestion of asbestos in food or water may result in health hazards. However, because of concern that there may be potential health impacts not yet identified, there are federal regulations specifying asbestos limitations in ambient water and in products such as food processing filters.

With regard to asbestos contact with the skin, there is currently no evidence to indicate that asbestos fibers can penetrate the skin tissue. Some workers have indicated that asbestos fibers irritate the skin resulting in a rash similar to that experienced with handling of other fibrous materials such as fiberglass insulation.

Federal Regulatory Programs

EPA and OSHA have major responsibility for regulatory control over exposure to asbestos. Emissions of asbestos to the ambient air are controlled under Section 112 of the Clean Air Act, which establishes the National Emission Standards for Hazardous Air Pollutants (NESHAPs). The regulations specify control requirements for most asbestos emissions, including work practices to be followed to minimize the release of asbestos fibers during handling of asbestos waste materials. These regulations do not identify a safe threshold level for airborne asbestos fibers. For additional information about the NESHAPs regulations for asbestos, refer to the Code of Federal Regulations (40 CFR Part 61, Subpart M).

The OSHA regulations are established to protect workers handling asbestos or asbestos-containing products. The current OSHA regulations include a maximum workplace airborne asbestos concentration limit of 2 fibers/cc on an 8-hour time weighted average basis, and a ceiling limit of 10 fibers/cc in any 15-minute period. The standard includes requirements for respiratory protection and other safety equipment, and work practices to reduce indoor dust levels. For details regarding the OSHA regulations, refer to the Code of Federal Regulations (29 CFR Part 1910).

EPA has implemented a separate regulation under the Toxic Substances Control Act (TSCA) to handle the problem of asbestos construction materials used in schools. This regulation requires that all schools be inspected to determine the presence and quantity of asbestos and that the local community be notified as well as the building posted. Corrective actions, such as asbestos removal or encapsulation, are currently left to the discretion of the school administrators. EPA provides technical assistance under this program through the Appendix B contacts or the toll-free TSCA hotline: 1-800-424-9065 (554-1404 in Washington, DC). The specific details of the TSCA program are contained in the Code of Federal Regulations (40 CFR Part 763, Subpart F).

The Asbestos School Hazard Abatement Act of 1984 (ASHAA) establishes a $600 million grant and loan program to assist financially needy schools with asbestos abatement projects. The program also includes the compilation and distribution of information concerning asbestos, and the establishment of standards for abatement projects and abatement contractors. Under this program, centers to train contractors on asbestos handling and abatement have been established at the Georgia Institute of Technology, Atlanta, GA, and are scheduled to open in June 1985 at both Tufts University, Medford, MA, and at the University of Kansas, Lawrence, KN. Additional information can be obtained through the toll-free ASHAA hotline: 1-800-835-6700 (554-1404 in Washington, DC).

Wastes containing asbestos are not hazardous wastes under the Resource Conservation and Recovery Act (RCRA). However, because state regulations can be more restrictive than the federal regulations under RCRA, some states may have listed asbestos-containing wastes as hazardous wastes. Since this will greatly impact on transportation and disposal of the waste, the state hazardous waste agency should be contacted. A list of state hazardous waste agencies may be obtained by calling the RCRA hotline: 1-800-424-9346 (382-3000 in Washington, DC). Current nonhazardous waste regulations under RCRA pertain to facility siting and general operation of disposal sites (including those that handle asbestos). Details concerning these RCRA requirements are contained in the Code of Federal Regulations (40 CFR Part 257).

Other federal authorities and Agencies controlling asbestos include: the Clean Water Act, under which EPA has set standards for asbestos levels in effluents to navigable waters; the Mine Safety and Health Administration, which oversees the safety of workers involved in the mining of asbestos; the Consumer Product Safety Commission; the Food and Drug Administration; and the Department of Transportation.

State and local agencies may have more stringent standards than the federal requirements; these agencies should be contacted prior to any asbestos removal or disposal operation.

2 Quantities and Uses of Asbestos

Asbestos has been mined and used commercially in the U.S. since the early 1900s. U.S. consumption of asbestos increased to a peak of 800,000 tons per year in the early 1970s. Since then, consumption has dropped by more than 70 percent. However, much of the material originally installed in buildings may still be present.

The potential existence of asbestos in commercial products can be assessed first by understanding the physical and chemical characteristics of asbestos-containing products and their uses. This section describes the appearance, composition, friability, use, and market share of the most common asbestos-containing products.

Table 1 summarizes information on these products, many of which are still being manufactured. However, because of the recognized health risk, the manufacture of a few asbestos products has been banned. In addition, the concern of industry for exposure of their workers and the public, and the increased availability of substitute products, has rapidly reduced the use of asbestos.

Friction Products

Asbestos is used in brake linings for automobiles, buses, trucks, railcars, and industrial machinery, and in vehicle or industrial clutch linings. Asbestos-containing brake linings include drum brake linings, disc brake pads, and brake blocks. In the past, asbestos linings have accounted for up to 99 percent of this market. Friction materials are generally tough and nonfriable, but they release asbestos dust during fabrication operations. In addition, accumulated dust in a brake drum from lining wear contains high levels of asbestos. Brake installation facilities (e.g., city bus service centers, tire and brake shops) may generate significant quantities of asbestos waste. Substitute nonasbestos brake linings have been developed and are beginning to replace asbestos lining in some applications.

Plastic Products

Plastic products include resilient vinyl and asphalt floor coverings, asphalt roof coatings, and traditional molded plastic products such as a cooking pot handle or plastic laboratory sink. The products in this category are usually tough and inflexible. The asbestos in these products is tightly bound and is not released under typical conditions of use. However, any sawing, drilling, or sanding of these products during installation or removal would result in the release of asbestos dust.

Table 1. Summary of Asbestos-Containing Products

Product	Average percent asbestos	Binder	Dates used
Friction products	50	Various polymers	1910-present
Plastic products			
Floor tile and sheet	20	PVC, asphalt	1950-present
Coatings and sealants	10	Asphalt	1900-present
Rigid plastics	<50	Phenolic resin	?-present
Cement pipe and sheet	20	Portland cement	1930-present
Paper products			
Roofing felt	15	Asphalt	1910-present
Gaskets	80	Various polymers	?-present
Corrugated paper pipe wrap	80	Starches, sodium silicate	1910-present
Other paper	80	Polymers, starches, silicates	1910-present
Textile products	90	Cotton, wool	1910-present
Insulating and decorative products			
Sprayed coating	50	Portland cement, silicates, organic binders	1935-1978
Troweled coating	70	Portland cement, silicates	1935-1978
Preformed pipe wrap	50	Magnesium carbonate, calcium silicate	1926-1975
Insulation board	30	Silicates	Unknown
Boiler insulation	10	Magnesium carbonate, calcium silicate	1890-1978
Other uses	<50	Many types	1900-present

Vinyl (linoleum) and asphalt flooring are used in many types of construction. Vinyl-asbestos flooring has about a 90 percent share of the resilient floor covering market. These materials are not friable, and asbestos is released primarily through sawing or sanding operations during installation, remodeling, and removal. Asphalt-asbestos coatings, used primarily as roof sealants, generally remain flexible and nonfriable, but can become friable or brittle as they age.

Cement Pipe and Sheet

Asbestos-cement (A-C) pipe has been widely used for water and sewer mains, and is occasionally used for electrical conduits, drainage pipe, and vent pipes. Asbestos-cement sheet, manufactured in flat or corrugated panels and shingles, has been used primarily for roofing and siding, but also for cooling tower fill sheets, canal bulkheads, laboratory tables, and electrical switching gear panels. Asbestos-cement products are dense and rigid with gray coloration, unless the material is lined or coated. The asbestos in these products is tightly bound, and would not be released to the air under typical conditions of use. However, any sawing, drilling, or sanding of these products during installation or renovation would result in release of asbestos dust. In addition, the normal breakage and crushing involved in the demolition of structures can release asbestos fibers from these materials. For this reason they are subject to the NESHAPs regulation during demolition operations. Also, normal use of A-C pipe for water or sewer mains has been shown to release asbestos fibers to the fluid being carried.

By the late 1970s, A-C pipe had a 40 percent share of the water main market and a 10 percent share of the sewer main market. However, since A-C pipe has only been in existence for 50 years, it only accounts for a small fraction of the total pipe in place in the United States.

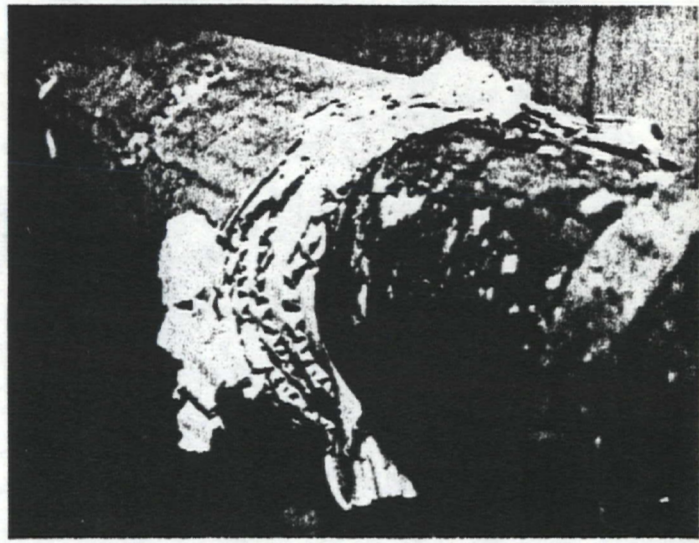
Paper Products

Roofing felts, gaskets, and other paper products are manufactured on conventional papermaking equipment using asbestos fibers instead of cellulose. The raw asbestos paper produced in this process has a high asbestos content (~85 percent), but is typically coated or laminated with other materials in the final product. The asbestos fibers in most paper products are sufficiently bound to prevent their release during normal product use. Cutting or tearing the material during installation, use, or removal would result in the release of asbestos dust.

Asbestos-containing roofing felt has been widely used for application of "built-up" roofs. Built-up roofing is used on a flat surface, and consists of alternating layers of roofing felt and asphalt. The roofing felt consists of asbestos paper, saturated and coated with asphalt. Asphalt-asbestos roofing shingles for residential structures, made from roofing felt coated with asphalt, were reportedly used for only a short time between 1971 and 1974.

Other asbestos-containing paper products include pipeline wrap, millboard, rollboard, commercial insulating papers, and a variety of specialty papers. Pipeline wrap is used to protect underground pipes from corrosion, particularly in the oil and gas industry. Millboard and rollboard are laminated paper products used in commercial construction such as walls and ceilings. Commercial insulating papers are used for high temperature applications in the metals

Figure 3. Corrugated asbestos paper pipe wrap.



and ceramics industries, for low-grade electrical insulation, and for fireproofing steel decks in building construction. Corrugated asbestos paper was used for pipe coverings (illustrated in Figure 3), block insulation, and specialty panel insulation. Although these uses have generally been discontinued, significant amounts are typically found in older structures. These products are generally considered friable.

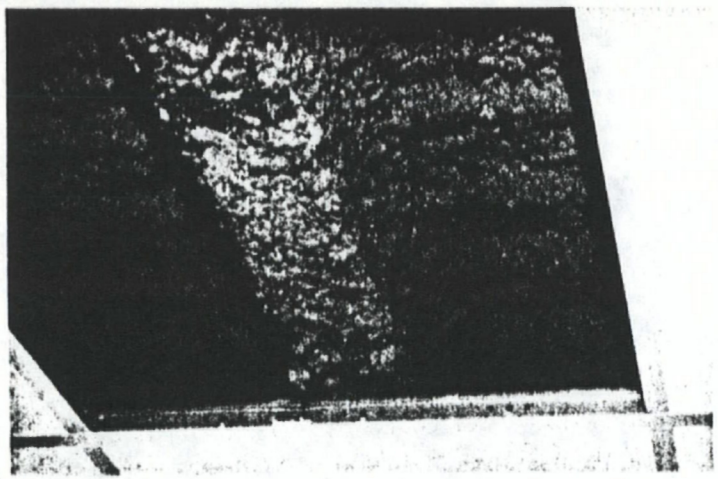
Textile Products

Asbestos yarn, cloth, and other textiles are made using conventional textile manufacturing equipment. These materials are used to manufacture fire-resistant curtains or blankets, protective clothing, electrical insulation, thermal insulation, and packing seals. The raw textile products have a high asbestos content (~85 percent). However, they are typically coated or impregnated with polymers before assembly into a final product, which is not required to be labeled as containing asbestos and typically is not so labeled. These products may release asbestos dust if cut or torn, or for some products, during normal use. There still remains a significant quantity of non-coated fabrics in use, especially in schools and fire departments.

Insulating and Decorative Products

Asbestos-containing thermal insulation generally refers to sprayed and trowelled asbestos coatings, and molded or wet-applied pipe coverings. These materials generally have an asbestos content of 50 to 80 percent. The coatings were commonly applied to steel I-beams and decks (illustrated in Figure 4), concrete

Figure 4. Asbestos spray insulation on an I-beam and steel deck.



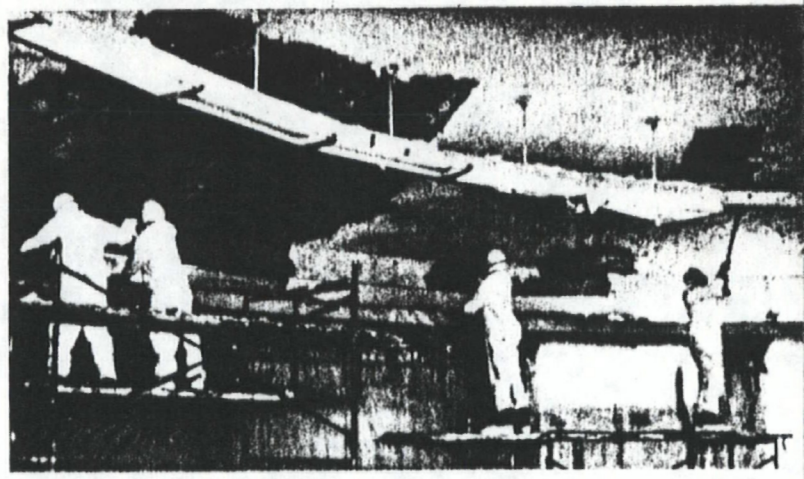
ceilings and walls (illustrated in Figure 5), and hot water tanks and boilers. The coatings were applied primarily for thermal insulation, although in many cases the coating also provided acoustical insulation and a decorative finish. Sprayed coatings typically have a rough, fluffy appearance, while trowelled coatings have a smooth finish and may be covered with a layer of plaster or other nonasbestos material. Both sprayed and trowelled asbestos coatings are considered friable in most applications. Most spray-applied asbestos coatings were banned for fireproofing/insulating in 1973, and for decorative purposes in 1978.

Asbestos insulation board was used as a thermal/fireproofing barrier in many types of walls, ceilings, and ducts or pipe enclosures. This material looks like A-C sheet, but is less dense and much more friable. High asbestos dust levels have been measured for many board handling operations, including simple unloading of uncut sheets.

Pipe Insulation

Preformed pipe coverings having an asbestos content of about 50 percent were used for thermal insulation on steam pipes in industrial, commercial, institutional, and residential applications. This product is usually white and chalky in appearance and was typically manufactured in 3-foot long, half-round sections, joined around the pipe using plaster-saturated canvas or metal bands. Typical examples of preformed pipe insulation are illustrated

Figure 5. Sprayed asbestos-containing materials being removed from a concrete ceiling.



in Figures 6 and 7. This covering was applied on straight pipe sections, while wet-applied coatings were used on elbows, flanges, and other irregular surfaces. The preformed pipe coverings may be slightly more dense than the insulating coatings, but are still very friable. The installation of wet-applied and preformed asbestos insulations were banned in 1975, however, significant amounts are typically found in older structures.

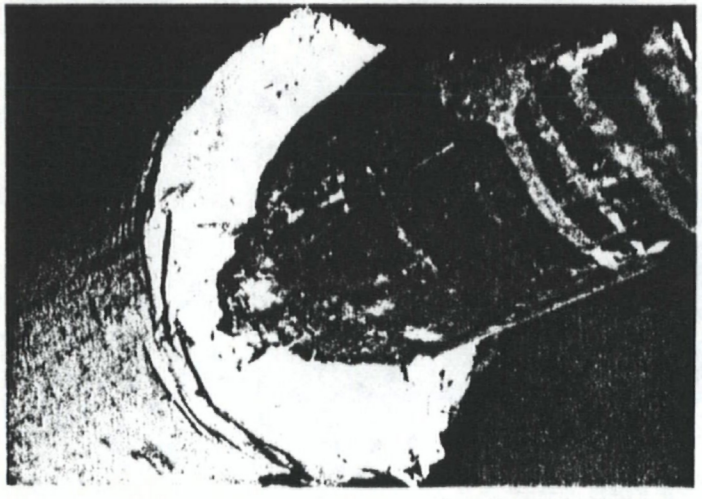
Boilers and Hot Water Tanks

Preformed block insulation was used as thermal insulation on boilers, hot water tanks, and heat exchangers (illustrated in Figure 8) in industrial, commercial, institutional, and residential applications. These blocks are commonly chalky white, 2 inches thick, from 1 to 3 feet in length and held in place around the boiler by metal wires and/or expanded metal lath. A plaster-saturated canvas was often utilized as a final covering or wrap. Asbestos block insulation is friable and rapidly deteriorates in a high humidity environment or when exposed to water. The installation of this type of asbestos insulation was banned by EPA in 1975.

Other Uses

Other uses of asbestos have included: exterior siding shingles, shotgun shell base wads, asphalt paving mix, spackle and joint patching compounds, artificial fireplace logs for gas-burning fireplaces, and artificial snow. The use of asbestos as artificial logs in

Figure 6. Preformed asbestos pipe insulation with canvas wrap.



gas-burning fireplace systems was banned in 1977, while the use of asbestos as an ingredient in spackle and joint compounds was banned in 1978. Asbestos is still used in oil/gas drilling fluids, added at a concentration of approximately 1 percent.

Figure 7. Preformed block insulation with canvas wrap on a pipe.

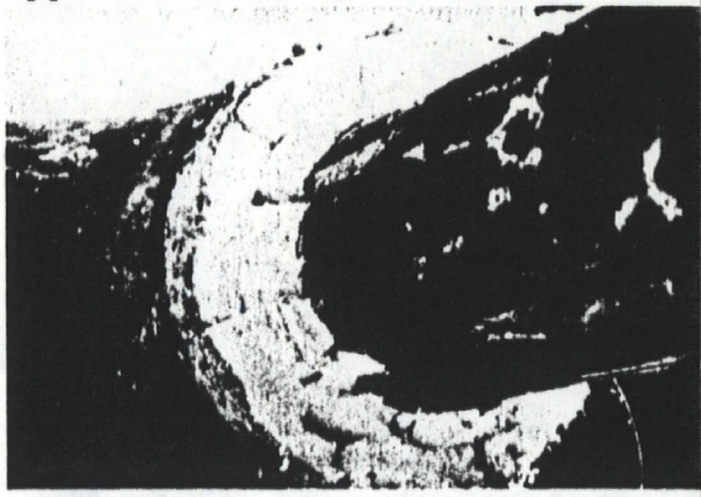
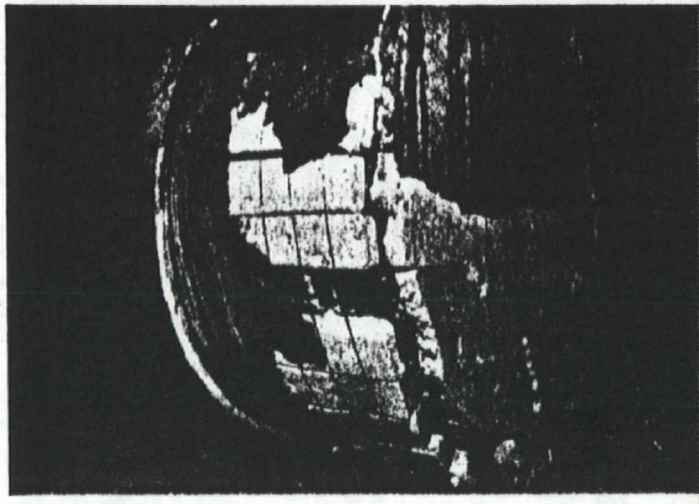


Figure 8. Asbestos insulation on a heat exchanger.



3 Generation of Asbestos Wastes

Asbestos-containing wastes are generated by a variety of processes including mining and milling asbestos ore, manufacturing and fabricating asbestos products, and removing asbestos building materials prior to demolition or renovation operations. The recommended methods for handling these wastes are discussed below.

Mining and Milling

Asbestos is "manufactured" by mining the ore deposit and separating the fibers from the nonasbestos rock. There are currently three active asbestos mines in the U.S., at Copperopolis and Santa Rita, California, and at Hyde Park, Vermont. Seven other mines closed in the 1970s: three in Arizona, two in California, and two in North Carolina. Asbestos mines generate a large quantity of waste rock having insufficient asbestos content for additional processing. This waste is typically piled in an area adjacent to the mine. The Mine Safety Health Administration enforces asbestos exposure limits for mine workers. For additional information, refer to the Code of Federal Regulations (30 CFR Parts 55-57 and 71).

The process of separating asbestos fibers from the mined ore, and grading and packaging these fibers according to length, is called milling. Asbestos mills are located at the mine sites in Copperopolis and Hyde Park, while the Santa Rita ore is hauled to a mill at King City, California. Asbestos mills generate a large quantity of waste rock, called tailings, that contain residual amounts of asbestos. Mills also generate asbestos-containing waste from air cleaning control devices used to meet EPA and OSHA requirements. EPA requires all asbestos-containing wastes from mills to be disposed without any visible emissions to the outside air, or certain wetting practices must be used to control emissions. Tailings are usually disposed by loading on a conveyor belt and dumping on an onsite waste pile. Emission control during transport and dumping is usually achieved by wetting, although local exhaust ventilation may occasionally be used.

Manufacturing and Fabricating Asbestos Products

Asbestos products are manufactured by combining the milled asbestos fibers with binders, fillers, and other materials. The resultant mixture, which may be either dry or wet, is molded, formed or sprayed, and then cured or dried. Some products require further machining or coating operations prior to their sale. Manufactured products may then be fabricated by another manufacturer, or by the installer or final consumer. Manufacturing and fabricating operations generate the following asbestos-containing wastes:

- Empty asbestos shipping containers;
- Process wastes such as cuttings, trimmings, and off-specification/reject material;
- Housekeeping waste from sweeping or vacuuming; and
- Pollution control device waste from dust capture systems.

Waste Handling and Containerization

Process wastes and housekeeping waste should be wetted before packaging using a mixture of surfactant (e.g., soap) and water, in a fine mist. Empty shipping bags can be flattened and packaged under hoods exhausting to a pollution control device. Empty shipping drums are difficult to thoroughly clean, and should be sealed and disposed of or used to contain other asbestos wastes for disposal. Air pollution control device waste is usually packaged directly by connecting a container to the waste hopper outlet. Vacuum bags or disposable paper filters should not be cleaned, but rather should be sprayed with a fine water mist and placed intact into a proper container. Additional information on waste handling and containerization is presented under "Removal of Asbestos Materials in Buildings."

Removal of Asbestos Materials in Buildings

A significant quantity of asbestos-containing waste may be generated during removal of friable asbestos materials from buildings. EPA regulations address the removal of friable asbestos materials prior to demolition or renovation of buildings in the Code of Federal Regulations (40 CFR Part 61, Subpart M). Removal should also be considered for materials that may potentially become friable during the demolition or renovation activities. Currently, the federal regulations apply to larger structures, i.e., structures with more than four apartments with certain minimum quantities of asbestos-containing material. However, some state and local health agencies require removal of lesser quantities of asbestos from smaller buildings.

Regulatory requirements of EPA and OSHA include written advance notice to the regional NESHAPs contact (See Appendix A) of the planned removal, posting of warning signs, providing workers with protective equipment, wetting friable asbestos material to prevent emissions, monitoring indoor dust levels, and properly disposing of asbestos-containing wastes. It is also highly recommended that the work area be enclosed through the use of plastic barriers to prevent contamination of other parts of the structure. Guidelines for development of an asbestos removal contract are presented in a document entitled "Guide Specifications for the Abatement of Asbestos Release from Spray- or Trowel-Applied Materials in Buildings and Other Structures," published by the Foundation of the Wall and Ceiling Industry, 25 K Street N.E., Washington, DC 20002 (202-783-6580).

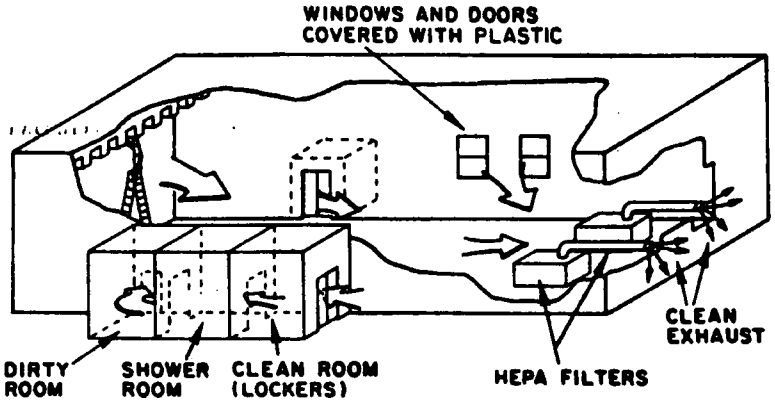
Asbestos removal contractors are encouraged to employ additional safety procedures beyond the minimum requirements of EPA and OSHA. The use of a negative air pressure system, utilizing fans and filters to exhaust air from the room, and a shower/decontamination facility for anyone exiting the area (as illustrated in Figure 9) is highly recommended. The air filters used in this system are high efficiency particulate air (HEPA) filters, rated for 99.97 percent removal efficiency for asbestos-size dust. These safeguards better protect workers and prevent contamination of the neighborhood. For additional information, refer to the EPA document entitled "Guidance for Controlling Friable Asbestos-Containing Materials in Buildings," (EPA 560/5-83-002), available from any of the Appendix B contacts or by calling EPA's toll-free TSCA hotline: 1-800-424-9065 (554-1404 in Washington, DC).

Waste Handling and Containerization

When the asbestos materials are prepared for removal, they are wetted with a water and surfactant mixture sprayed in a fine mist, allowing time between sprayings for complete penetration of the material. Once the thoroughly wetted asbestos material has been removed from a building component, EPA and OSHA regulations require the wastes to be containerized as necessary to avoid creating dust during transport and disposal. The generally recommended containers are 6-mil thick plastic bags, sealed in such a way to make them leak-tight. When using plastic bags it is important to minimize the amount of void space or air in the bag. This will help minimize any emissions should the bag burst under pressure. More thorough containerization may include double bagging, plastic-lined cardboard containers (illustrated in Figure 10), or plastic-lined metal containers. Asbestos waste slurries can be packaged in leak-tight drums if they are too heavy for the plastic bag containers. Both EPA and OSHA specify that the containers be tagged with a warning label. Either the EPA or OSHA label must be used.

CAUTION
CONTAINS ASBESTOS FIBERS
AVOID OPENING OR BREAKING CONTAINER
BREATHING ASBESTOS IS HAZARDOUS TO YOUR HEALTH
or
CAUTION
CONTAINS ASBESTOS FIBERS
AVOID CREATING DUST
MAY CAUSE SERIOUS BODILY HARM

Figure 9. Negative air pressure system.



In situations where pipes or other facility components containing asbestos materials are removed as sections without first removing the asbestos, 6-mil plastic can be used to wrap the section sufficiently to create a leak tight container. There are currently no regulatory requirements that govern the time period that waste can remain on-site before transport to a disposal site. However, recognizing the health risk and potential liabilities associated with accidental exposure, waste should be guarded (i.e., protected against public access, such as by a fence or in a locked building) and transported as soon as possible.

Figure 10. Plastic-lined cardboard container with asbestos waste.

Cleanup

After the asbestos-containing materials have been removed, all plastic barriers should be removed and the facility should be thoroughly washed. The plastic used to line the walls, floors, etc., should be treated as asbestos waste and containerized appropriately. Cleanup of asbestos debris may be done with a HEPA vacuum cleaner. Any asbestos-containing waste collected by the HEPA vacuum cleaner must be appropriately bagged, labeled, and disposed.

All areas of the facility that were potentially exposed to asbestos fibers should be washed down. Several washings should be performed along with air sampling and analysis to assure a low airborne asbestos fiber concentration. Various regulatory agencies have targeted asbestos fiber concentrations in the range of 0.001 to 0.0001 fibers/cc as a level desirable in the building air after cleanup. For example, the State of Arizona has specified 0.001 fibers/cc as a level above which additional cleanup is required, and British researchers have identified a level of 0.0001 fibers/cc to be attainable after cleanup. In some cases, it may not be possible to remove all asbestos due to the irregularity or porosity of the subsurface materials. In these situations, it may be necessary to spray an encapsulating paint over the surface to eliminate the potential for fiber release. For further information on encapsulants, contact any of the Appendix B Regional Asbestos Coordinators or call EPA's toll-free TSCA hotline: 1-800-424-9065 (554-1404 in Washington, DC).

Alternate Handling Techniques

Alternative techniques for removing asbestos materials from buildings must receive prior approval from EPA. To date, the only alternate technique is by vacuum truck. Vacuum trucks will be reviewed by EPA on a case-by-case basis. The one system found to be acceptable by EPA has demonstrated the capability of removing asbestos materials in a wet condition. The asbestos material, contained within the truck as a slurry, is transported to the final disposal site. The air from the vacuum intake is dried and exhausted through a fabric filter located on the truck. Final filtration of exhaust air is through a HEPA filter.

4 Transport of Asbestos Waste

For the purpose of this manual, transport is defined as all activities from receipt of the containerized asbestos waste at the generation site until it has been unloaded at the disposal site. Current EPA regulations state that there must be no visible emissions to the outside air during waste transport. However, recognizing the potential hazards and subsequent liabilities associated with exposure, the following additional precautions are recommended.

Recordkeeping

Before accepting wastes, a transporter should determine if the waste is properly wetted and containerized. The transporter should then require a chain-of-custody form signed by the generator. A chain-of-custody form may include the name and address of the generator, the name and address of the pickup site, the estimated quantity of asbestos waste, types of containers used, and the destination of the waste. The chain-of-custody form should then be signed over to a disposal site operator to transfer responsibility for the asbestos waste. A copy of the form signed by the disposal site operator should be maintained by the transporter as evidence of receipt at the disposal site.

Waste Handling

A transporter should ensure that the asbestos waste is properly contained in leak-tight containers with appropriate labels, and that the outside of the containers are not contaminated with asbestos debris adhering to the container. If there is reason to believe that the condition of the asbestos waste may allow significant fiber release, the transporter should not accept the waste. Improper containerization of wastes is a violation of the NESHAPs regulation and should be reported to EPA. A list of NESHAPs contacts is provided in Appendix A.

Once the transporter is satisfied with the condition of the asbestos waste and agrees to handle it, the containers should be loaded into the transport vehicle in a careful manner to prevent the breaking of the containers. Similarly, at the disposal site, the asbestos waste containers should be transferred carefully to avoid fiber release.

Waste Transport

Although there are no regulatory specifications regarding the transport vehicle, it is recommended that vehicles used for transport of containerized asbestos waste have an enclosed carrying compartment or utilize a canvas covering sufficient to contain the transported waste, prevent damage to containers, and prevent fiber release. Transport of large quantities of asbestos waste is commonly conducted in a 20-cubic yard "roll off" box, which should also be covered. Vehicles that use compactors to reduce waste volume should not be used because these will cause the waste containers to rupture. Vacuum trucks used to transport waste slurry must be inspected to ensure that water is not leaking from the truck.

5 Disposal of Asbestos Wastes

Disposal involves the isolation of asbestos waste material in order to prevent fiber release to air or water. Landfilling is recommended as an environmentally sound isolation method because asbestos fibers are virtually immobile in soil. Other disposal techniques such as incineration or chemical treatment are not feasible due to the unique properties of asbestos. EPA has established asbestos disposal requirements for active and inactive disposal sites under NESHAPs (40 CFR Part 61, Subpart M) and specifies general requirements for solid waste disposal under RCRA (40 CFR Part 257). Advance EPA notification of the intended disposal site is required by NESHAPs.

Selecting a Disposal Facility

An acceptable disposal facility for asbestos wastes must adhere to EPA's requirements of no visible emissions to the air during disposal, or minimizing emissions by covering the waste within 24 hours. The minimum required cover is 6 inches of nonasbestos material, normally soil, or a dust suppressing chemical. In addition to these federal requirements, many state or local governing agencies require more stringent handling procedures. These agencies usually supply a list of "approved" or licensed asbestos disposal sites upon request. Solid waste control agencies are listed in local telephone directories under state, county, or city headings. A list of state solid waste agencies may be obtained by calling the RCRA hotline: 1-800-424-9346 (382-3000 in Washington, DC). Some landfill owners or operators place special requirements on asbestos waste, such as placing all bagged waste into 55-gallon metal drums. Therefore, asbestos removal contractors should contact the intended landfill before arriving with the waste.

Receiving Asbestos Waste

A landfill approved for receipt of asbestos waste should require notification by the waste hauler that the load contains asbestos. The landfill operator should inspect the loads to verify that asbestos waste is properly contained in leak-tight containers and labeled appropriately. The EPA should be notified if the landfill operator believes that the asbestos waste is in a condition that may cause significant fiber release during disposal. A list of EPA contacts for disposal is provided in Appendix A. In situations when the wastes are not properly containerized, the landfill operator should thoroughly soak the asbestos with a water spray prior to unloading, rinse out the truck, and immediately cover the wastes with nonasbestos material prior to compacting the waste in the landfill.

Waste Deposition and Covering

Recognizing the health dangers associated with asbestos exposure, the following procedures are recommended to augment current federal requirements:

- Designate a separate area for asbestos waste disposal. Provide a record for future landowners that asbestos waste has been buried there and that it would be hazardous to attempt to excavate that area. (Future regulations may require property deeds to identify the location of any asbestos wastes and warn against excavation.)
- Prepare a separate trench to receive asbestos wastes. The size of the trench will depend upon the quantity and frequency of asbestos waste delivered to the disposal site. The trenching technique allows application of soil cover without disturbing the asbestos waste containers. The trench should be ramped to allow the transport vehicle to back into it, and the trench should be as narrow as possible to reduce the amount of cover required. If possible, the trench should be aligned perpendicular to prevailing winds.
- Place the asbestos waste containers into the trench carefully to avoid breaking them. Be particularly careful with plastic bags because when they break under pressure asbestos particles can be emitted.
- Completely cover the containerized waste within 24 hours with a minimum of 6 inches of nonasbestos material. Improperly containerized waste is a violation of the NESHAPs and EPA should be notified.

However, if improperly containerized waste is received at the disposal site, it should be covered immediately after unloading. Only after the wastes, including properly containerized wastes, are completely covered, can the wastes be compacted or other heavy equipment run over it. During compacting, avoid exposing wastes to the air or tracking asbestos material away from the trench.

- For final closure of an area containing asbestos waste, cover with at least an additional 30 inches of compacted nonasbestos material to provide a 36-inch final cover. To control erosion of the final cover, it should be properly graded and vegetated. In areas of the U.S. where excessive soil erosion may occur or the frost line exceeds three feet, additional final cover is recommended. In desert areas where vegetation would be difficult to maintain, 3-6 inches of well graded crushed rock is recommended for placement on top of the final cover.

Controlling Public Access

Under the current NESHAPs regulation, EPA does not require that a landfill used for asbestos disposal use warning signs or fencing if it meets the requirement to cover asbestos wastes. However, under RCRA, EPA requires that access be controlled to prevent exposure of the public to potential health and safety hazards at the disposal site. Therefore, for liability protection of operators of landfills that handle asbestos, fencing and warning signs are recommended to control public access when natural barriers do not exist. Access to a landfill should be limited to one or two entrances with gates that can be locked when left unattended. Fencing should be installed around the perimeter of the disposal site in a manner adequate to deter access by the general public. Chain-link fencing, 6-feet high and topped with a barbed wire guard, should be used. More specific fencing requirements may be specified by local regulations. Warning signs should be displayed at all entrances and at intervals of 330 feet or less along the property line of the landfill or perimeter of the sections where asbestos waste is deposited. The sign should read as follows:

ASBESTOS WASTE DISPOSAL SITE
BREATHING ASBESTOS DUST
MAY CAUSE LUNG DISEASE AND CANCER

Recordkeeping

For protection from liability, and considering possible future requirements for notification on disposal site deeds, a landfill owner should maintain documentation of the specific location and quantity of the buried asbestos wastes. In addition, the estimated depth of the waste below the surface should be recorded whenever a landfill section is closed. As mentioned previously, such information should be recorded in the land deed or other record along with a notice warning against excavation of the area.

6 Costs of Handling Asbestos

The costs of handling asbestos waste are highly variable. This variability is largely due to the range in handling practices, from those required to achieve minimal compliance with regulations to the use of extra safety precautions not required by law. However, to help avoid being charged inflated fees for asbestos handling, all cost data should be compared by considering a detailed description of the work practices associated with each estimate.

Costs for disposal of containerized asbestos waste are not well documented. A few disposal sites using special handling techniques have quoted fees ranging from $5 to $50 per cubic yard (about four 55-gallon containers). Other sites may not accept asbestos waste. Costs of hiring a waste hauler for transport of containerized asbestos waste depends on the quantity of waste and distance to an approved disposal site. Also, transportation charges may vary based on the degree of containerization, because rigid containers generally require less careful handling than plastic bags.

The overall cost for removal of friable asbestos from buildings, including transport and disposal, generally varies from $2 to $10 per square foot. About the same price range applies per linear foot for pipe insulation. Since this is a complicated handling operation, prices are highly dependent on each contractor's work practices. Higher prices are charged for safeguards that reduce the potential for exposure of building occupants, such as: (1) continuous fiber level monitoring, (2) use of "negative air pressure" systems, (3) special cleanup and air testing at job completion, and (4) treating stripped porous surfaces with encapsulants. Other than dust control methods, the greatest factor affecting cost is usually the nature of the asbestos-coated surface. For example, a smooth concrete ceiling is much more easily stripped than a corrugated metal deck. The cost of asbestos removal generally includes the price of waste hauling and disposal, but this should be confirmed on a case-by-case basis.

Other Sources of Information on Asbestos

Brandner, W., *Asbestos Exposure Assessment in Buildings Inspection Manual*, EPA Region 7, Kansas City, Missouri, October 1982.

The Foundation of the Wall and Ceiling Industry, Washington, DC, *Guide Specifications for the Abatement of Asbestos Release from Spray-or Trowel-Applied Materials in Buildings and Other Structures*, December 1981.

Kim, K. S., and D. E. Kuivinen, *Assessment of Potential Exposure to Friable Insulation Materials Containing Asbestos*, NASA Technical Memorandum 81435, April 1980.

Levadie, B., ed., *Definitions for Asbestos and Other Health-Related Silicates*, ASTM, Philadelphia, Pennsylvania. ASTM Special Technical Publication 834, PCN 04-834000-17, July 1984.

Natale, A., and H. Levins, *Asbestos Removal and Control*, Source Finders and Information Corp., Voorhees, NJ, 1984.

Piper, S. and M. Grant, *NESHAPs Asbestos Demolition and Renovation Inspection Report*, GCA Corporation, Bedford, MA, under EPA Contract No. 68-02-3961, August 1984.

U.S. Department of Commerce, National Bureau of Standards, *Guidelines for Assessment and Abatement of Asbestos-Containing Materials in Buildings*, Center for Building Technology, Washington, DC, NBSIR-83-2688, May 1983.

U.S. Department of Health, Education and Welfare, *Asbestos Exposure*, National Cancer Institute, Bethesda, Maryland, DHEW Publication No. (NIH) 78-1622, May 1978.

U.S. Environmental Protection Agency, *Asbestos-Containing Materials in School Buildings: A Guidance Document*, Parts 1 and 2, Office of Toxic Substances, Washington, DC, EPA 450/2-78-014, March 1979.

U.S. Environmental Protection Agency, *Guidance for Controlling Friable Asbestos-Containing Materials in Buildings*, Office of Pesticides and Toxic Substances, Washington, DC, EPA 560/5-83-002, March 1983.

U.S. Occupational Safety and Health Administration, *Preliminary Regulatory Impact and Regulatory Flexibility Analysis of the Proposed Revisions to the Standard for Regulating Occupational Exposure to Asbestos*, PB84-198225, 30 March 1984.

Appendix A

U.S. Environmental Protection Agency Regional Asbestos NESHAPs Contacts

(For information on NESHAPs rule compliance and disposal)

Region 1
Asbestos NESHAPs Contact
Air Management Division
USEPA
JFK Federal Building
Boston, MA 02203
(617) 223-4872

Region 2
Asbestos NESHAPs Contact
Air & Waste Management Division
USEPA
26 Federal Plaza
New York, NY 10007
(212) 264-2611

Region 3
Asbestos NESHAPs Contact
Air Management Division
USEPA
841 Chestnut Street
Philadelphia, PA 19107
(215) 597-6552

Region 4
Asbestos NESHAPs Contact
Air, Pesticide & Toxic Management
USEPA
345 Courtland Street N.E.
Atlanta, GA 30365
(404) 881-3067

Region 5
Asbestos NESHAPs Contact
Air Management Division
USEPA
230 S. Dearborn Street
Chicago, IL 60604
(312) 886-6793

Region 6
Asbestos NESHAPs Contact
Air & Waste Management Division
USEPA
1201 Elm Street
Dallas, TX 75270
(214) 767-9869

Region 7
Asbestos NESHAPs Contact
Air & Waste Management Division
USEPA
726 Minnesota Avenue
Kansas City, KS 66101
(913) 236-2834

Region 8
Asbestos NESHAPs Contact
Air & Waste Management Division
USEPA
1860 Lincoln Street
Denver, CO 80295
(303) 844-3763

Region 9
Asbestos NESHAPs Contact
Air Management Division
USEPA
215 Fremont Street
San Francisco, CA 94105
(415) 974-7648

Region 10
Asbestos NESHAPs Contact
Air & Toxics Management Division
USEPA
1200 Sixth Avenue
Seattle, WA 98101
(206) 442-2724

Appendix B

U.S. Environmental Protection Agency Regional Asbestos Coordinators

(For information on asbestos identification, health effects, abatement options, analytic techniques, monitoring, asbestos in schools, and contract documents)

Region 1
Regional Asbestos Coordinator
USEPA
JFK Federal Building
Boston, MA 02202
(617) 223-0585

Region 2
Regional Asbestos Coordinator
USEPA
Woodbridge Avenue
Edison, NJ 08837
(201) 321-6668

Region 3
Regional Asbestos Coordinator
USEPA
841 Chestnut Street
Philadelphia, PA 19107
(215) 597-9859

Region 4
Regional Asbestos Coordinator
USEPA
345 Courtland Street, N.E.
Atlanta, GA 30365
(404) 881-3864

Region 5
Regional Asbestos Coordinator
USEPA
230 S. Dearborn Street
Chicago, IL 60604
(312) 886-6879

Region 6
Regional Asbestos Coordinator
USEPA
First International Building
1291 Elm Street
Dallas, TX 75270
(214) 767-5314

Region 7
Regional Asbestos Coordinator
USEPA
726 Minnesota Avenue
Kansas City, KS 66101
(913) 236-2838

Region 8
Regional Asbestos Coordinator
USEPA
1860 Lincoln Street
Denver, CO 80295
(303) 837-3926

Region 9
Regional Asbestos Coordinator
USEPA
215 Fremont Street
San Francisco, CA 94105
(415) 454-8588

Region 10
Regional Asbestos Coordinator
USEPA
1200 Sixth Avenue
Seattle, WA 98101
(206) 442-2870